JOURNAL

OF THE

AMERICAN FOUNDRYMEN'S

ASSOCIATION.

VOL. I. OCTOBER, 1896. No. 4.

PROCEEDINGS OF THE WESTERN FOUNDRYMEN'S ASSOCIATION.

The regular meeting was held Wednesday afternoon and evening at the Great Northern Hotel, Chicago, the President, Mr. A. W. McArthur, in the chair.

Mr. Curtis W. Shields, of the Ingersoll-Sergeant Drill Co., read the following paper on

"COMPRESSED AIR AND ITS ECONOMIES IN THE FOUNDRY."

Perhaps in no other operation in the foundry is air used to such good advantage as in hoists and cranes. By using direct acting hoists suspended from trolley tracks and using detachable air hose couplings, a casting or other weight can be readily conveyed to any part of the foundry or carried outside the foundry building to the machine or pattern shop, or in fact to any point around the establishment that may be desired, thus covering a field vastly wider than is possible with a traveler alone.

The great economy of the air hoist is well illustrated in the following record of actual work performed in the foundry of Messrs. Russell & Co., of Massillon, O. In making wheels for their traction engines, a molder and helper formerly made one

mold per day of a wheel 16 inches face by 66 inches diameter. During the entire operation of molding and pouring, 104 hoists and lowers were necessary. With the old crane, it took these two men from five to six minutes to turn a flask, when assisted by a laborer on the windlass. Now, with the air hoist, the laborer is done away with, and they turn a flask in two minutes. This saves in time alone 52 times 3½ minutes, or three hours per day, and the molder and helper make in the time saved by the air hoist two 58x12-inch wheels in addition to the large wheel, which formerly constituted a day's work.

In this same foundry a test of one of their jib cranes gave the following:

Area of piston, 452.39 square inches (24 inches diameter).

Height of lift, six feet.

Hoist, two feet to one foot of piston travel.

Weights lifted, 2,000, 4,000 and 5,000 pounds.

Main air receiver gauge, 100 feet from crane, registered 63 pound pressure.

Gauge on hoisting cylinder, 30, 40 and 45 pounds for the respective hoists.

It was found that it took 10 pounds of pressure on hoisting cylinder gauge to overcome the friction of the chains wrapping around the sheaves, as well as of the packing in the stuffing box of the piston rod and the frictional resistance of the piston against the cylinder walls.

The excess of 261.55, 523.9 and 654.87 pounds in the respective cases is, no doubt, due to the fact that the chains are hugging the sheaves tighter under the loads than when empty, and this increased friction must be overcome at the expense of pressure. The ten pounds required to overcome the load and frictional resistance of the chain, chain block, etc., in the crane itself is not altogether wasted, for the space in the cylinder between the piston and the head on the lifting side being once supplied with this amount is then ready to do useful work. A 24-inch cylinder with piston moved three feet would contain 28.275 cubic feet of free air if the gauge on the cylinder showed 30 pounds, or two atmospheres pressure, and 10 such hoists would use 282¾ cubic

feet of free air. This amount of air would not cost over one and one-half cents. With compressed air at five cents or less per 1,000 cubic feet of free air delivered at 100 pounds pressure, this is vastly cheaper than a gang of men on a windlass with the molders standing idle an indefinite time. The frictional loss in direct air hoists has been shown by tests made by the Whiting Foundry Equipment Co. not to exceed 15 per cent. A lot of 12 hoists taken at random showed a varying loss of from 9.2 to 23 per cent, average 12.9 per cent loss. Another lot of 10 averaged 14.65 per cent loss. Mr. Chas. O. Heggem, the well-known compressed air expert of the above company, uses compressed air for breaking test bars, and at the same time automatically recording the shrinkage and deflection. The pattern for the test bars is 24⅛ inches long, and in the case of a bar tested the register showed a shrinkage of 9-64 inches to the foot; deflection, ½ inch in 24 inches, and the bar, which was one inch square, broke under a pressure of 1,375 pounds.

In view of the great variety of ways (more or less unsatisfactory) of testing the qualities of iron as expressed last May at the meeting of the foundrymen in Philadelphia, Pa., it would appear that the majority of founders using air could adopt Mr. Heggem's idea with advantage.

Large compressed air traveling cranes are coming into use in foundries, and a short description of one at the works of the Ingersoll-Sergeant Drill Co., at Easton, Pa., which has a novel single eccentric reversing gear, may not be uninteresting.

This is a 20-ton traveling crane with a 40-foot span. It has three duplex air engines, one for each motion of the crane. The engines are reversible and very simple in construction, each cylinder having a valve which has both a rocking and a shifting motion, the cylinders having two sets of ports, one set direct and the other crossed or leading to the opposite ends of the cylinder. With this arrangement, only one eccentric is required for a cylinder, and the engine is reversed by shifting the valve by air. There are two air pipes leading to the valve chest of each engine, the other end of the pipes leading to a valve box on the cage of the crane. In this valve box are three slide valves operated by

levers which control the speed and direction of the three movements of the crane. When the levers of the valve box are in a central position, the ports in valve box are covered and the crane is stationary; but when moved in either direction, air is passed through one of the two pipes leading to an engine, which shifts the valve and brings one set of ports into play, making the engine run one way. When shifting the lever in the opposite direction, the air is passed through the other pipe leading to engine, the valve is shifted in the opposite direction and the engine is reversed in its movement.

The travel of the crane is 460 feet, and air is supplied to same through a continuous hose of about 480 feet in length, fastened to building at one end and to the crane at the other, and is held up at intervals of 25 feet with cast iron swivel sliders which move on channel beams bolted to the roof of the building. On the forward movement of crane, the hose is drawn out very nearly straight, and on the return movement, it fills in loops, the hose turning on the swivel joint as the two slides come together, making it set at right angles to the slides. In this position, the hose occupies very little room, the 480 feet, when looped up, using only about 10 feet of track.

Compressed air cranes have many advantages over those electrically driven for foundry work, as the dust and heat which materially affect the efficiency of electric motors have no appreciable effect on the air meters.

Few if any of the compressed air driven machines that have been introduced for foundry work serve a better end than the sand blast. By its aid castings that were hitherto cleaned with the greatest difficulty can now be cleaned in a remarkably short time and with a tithe of the exertion formerly necessary. For instance, a casting which was made with a core that was almost impossible to get out satisfactorily, and which took 45 minutes to clean by hand, was cleaned by the sand blast in 16 minutes. Six and one-half minutes of this time was occupied by chipping out a fin to allow the blast to reach the core. The waste sand from a sand blast can be used to advantage in making cores when mixed with the core sand in proportion of about one to four.

Another important use of compressed air is in connection with the molding machine. By its use the expense of stripping plates is entirely done away with, and by using an air jet to blow sand from the pattern instead of using a bellows and brush much time is saved. The use of air permits the molding machine to be moved to any part of the foundry, and it is decidedly cheaper to bring the molding machine to the sand pile than wheel the tons of sand to the machine.

A deeper draft is possible using air than can be obtained with a steam actuated machine. In general, a molding machine operated by compressed air is portable, independent of any foundation, and can be connected to the air main by a hose and used in any part of the foundry, which is not possible when using steam. It makes molds without the use of stripping plates, in fact uses ordinary split-wood or metal patterns fastened by wood screws to the pattern plate. This is accomplished by the use of an automatic rapping attachment which frees the pattern from the sand, without any amplitude of motion in the pattern while it is being drawn. This compressed air molding machine weighs and costs but little more than a hand machine and has all the advantages in point of output and size of flasks of power machines. Observation of an air actuated molding machine operated by two helpers at $1.50 per day each showed that on certain work containing 12 small cores per mold they put up 50 molds per day. Formerly it took four helpers at the same wages to make 50 molds by hand per day, thus saving in wages 50 per cent.

In another case, on new work, the first day two helpers at $1.50 each per day turned out 35 molds. The best record on this work for a molder working by the piece was seven molds per day.

The product of a molding machine can be greatly increased if the handling of the sand in shovels is done away with. This is accomplished by an air jet which, at 60 pounds pressure, will lift 100 pounds of sand per minute 20 feet high. A quarter-inch nozzle will use 90 cubic feet of free air per minute doing this duty. By elevating the sand to a bin overhead and then conveying it in a chute or pipe directly over the molding machine

much time and labor can be saved. A simple slide in the pipe forms a ready means of regulating the amount of sand served to the machine for each mold.

After deciding to adopt compressed air as a labor saving aid in the foundry, the most important points for consideration are the type or style of compressor to install, and its size or capacity. Only too frequently confined space, together with a disinclination to expend more than will barely suffice for present needs, act as a handicap and incline the founder to decide upon a plant that "will do somehow," rather than one that his cold, unbiased judgment would dictate as being best suited to his needs. It is the exception to find a plant too large even for present needs, for while starting out with the best intentions to allow for a reserve, the ingenious foundrymen originate so many little labor saving shop kinks that before long there is a demand for more air, and the engineer is told to "speed her up a few turns."

When it is decided to use air hoists, cranes, molding machines and other air actuated machinery, it is imperative to bear in mind that if the air supply stops through break-down or insufficient capacity, the whole foundry is practically at a standstill. If there is no air to operate the hoists the men cannot handle their work and great loss ensues.

It is clearly of the utmost importance that the source of air supply must be adequate to all reasonable demands and must be of such staunch and durable design and construction as will insure its ability to easily meet the increased duty when called upon to "speed up a few turns." These "few turns" usually mean about 20 per cent increase, and it is only the very best high duty compressors that will survive such a test.

It is an open question which must be largely decided by the individual conditions in each foundry, whether a steam driven or belt compressor is most desirable. Where there is shafting already in the foundry and a good dust-tight room can be provided, it is perhaps cheaper to put in the belt driven type. The steam compressor has its advantages, however, as it can be located in the engine room under the supervision of the engineer, and the necessity for shafting and belting is obviated. As the best

steam actuated compressors now use steam very nearly if not quite as economically as the majority of shop engines, low efficiency cannot be urged against their use with the same force as formerly.

The steam machine can be run at a speed to suit the requirements of the foundry by regulating the throttle. On the belt driven compressor a change of revolutions means a change of belts and pulleys. In both cases, a regulating or unloading device is desirable and economical, and regulates the compressor so that a constant pressure is kept in the receiver or reservoir. Compressors are now made in a variety of types to meet all the conditions and requirements of the various trades. Just as compound engines took the place of the cylinder engine, so now air compressors compress air in two or more stages while being driven in compound engines. This feature, combined with the well-known piston air inlet device, has resulted in the production of the "Triplex" compressor.

This is essentially a duplex steam machine with tandem two stage air cylinders, and was designed to fill the long-felt want of a compact, economical, high duty compressor. The advantages of this machine may be summarized as follows:

1. Self-contained and compact, using little or no foundation.
2. Duplex steam cylinders, with steam cranks at 90 degrees and air crank at 135 degrees from each steam crank.
3. Tandem compound air cylinders with perfect inter-cooler.
4. Fly wheels in direct line with air cylinders where work is expended.
5. All parts easily accessible.
6. Can be arranged with air cylinders for any pressure.
7. Steam cylinders cross compound.
8. Piston inlet air valve on low pressure air cylinder and all other inlet and discharge valves having vertical lift.

In all air compressors the hard work is done by the fly wheel. In a regular duplex machine the steam is cut off and the fly wheel is forcing the air piston against the maximum resistance doing this work around the angle of the pillow block, thus:

With the "triplex" this work is done by two fly wheels, both acting in a direct line with load, thus:

The piston inlet and vertical lift poppet valves are preferable to the old style horizontal poppet valve for many reasons. These horizontal valves are very apt to occasion endless trouble, particularly when located in the cylinder heads, as a broken stem or a loose nut permits the valve, or part of it, to drop into the cylinder.

It is not practicable to make poppet valves of any great diameter, hence in a large compressor it is necessary to use a number of these valves. This divides the air entering the cylinder into several small streams, which, passing over the surrounding heated surfaces, greatly increases the friction of the air entering the cylinder and decreases the capacity of the compressor.

By removing these inlet valves from the cylinder head, a large cooling surface equal to about three-quarters of its area is obtained. This is more valuable for cooling than the cylinder jacket alone, because the air is hottest after the piston passes the center of the cylinder.

Most of the difficulties and disadvantages of the poppet inlet valves have been successfully overcome by the piston inlet valve. This device comprises a hollow tail rod passing through a stuffing box in the back cylinder head; a hollow piston into which the air is admitted through the tail rod, and a ring valve of T section on each side of the hollow air piston head.

These ring valves allow the air to pass alternately into each end of the cylinder, and are actuated by means of their own inertia, opening or closing at the moment compression ceases or begins. These piston valves are exceedingly durable, as they are forged from a solid billet of dead soft open-hearth steel, are made without a weld. Severe tests of long duration have proved them to be practically indestructible, five years of constant duty night and day scarcely sufficing to show any appreciable wear on them. By means of the piston inlet a concentrated inlet current is secured.

A suitable sleeve or conduit pipe should be made to conduct to the tail rod inlet air drawn from a source outside of the engine room, most favorable to coolness, dryness and freedom from dust or other foreign matter. Air when admitted cold to the cylin-

der results in a larger volume of compressed air for a given diameter and stroke of cylinder. It is plain, therefore, that too much stress cannot be laid on the importance of a cold dry inlet, and an efficient method of water jacketing, particularly in the cylinder heads.

Transmission of power by compressed air has the advantages of certainty and regularity in action, simplicity in machinery, freedom from the possibility of fatal accidents and the assistance given to ventilation and cooling the shop. These last are considerations of much importance in many cases. Works employing this method do not require the supervision of a specially qualified expert, and the chances of interruption by accident through negligence are certainly less than in any other form of power transmission.

When we come to the question of laying out the piping for a foundry, it is well to remember that the head necessary to drive the air through the pipe is as the square of the velocity, and to obtain the best results the flow of air through the pipe should not exceed 20 feet per second. If this is borne in mind, air can be conveyed almost any distance with little or no loss.

The receiver should be placed in any convenient place and should be of a capacity not less than the rating of the compressor in cubic feet of free air per minute.

It is preferable to have the inlet pipe from the compressor enter the receiver near the top and the outlet near the bottom and at right angles to the inlet. A drain cock at the lowest point should be provided and a pressure gauge and safety valve on the top.

Leaks in air pipes are fortunately easy to find because of the hissing noise caused by the escaping air. This is an important point in comparing pneumatic with electric power transmission. Leaks in electric wires are hard to discover and are usually found after some damage has been done.

A little thought and attention given to the elimination of turns and angles in the pipe mains will amply repay for the trouble. It is economical to lead the air mains centrally and run smaller connections to points adjacent and convenient to the places where air is to be used.

If this is done, short lengths of hose pipe can be attached wherever most convenient for connection to hoists, molding machine, sand sifter or other apparatus, or the air can be used for the same purposes for which the bellows and brush are employed.

The Secretary then read a paper by Mr. George A. True, of the Whiting Foundry Equipment Co., on

"COMPRESSED AIR AS A HOISTING POWER IN THE FOUNDRY."

So much has been said and written upon the general uses of compressed air as a distributing power, that it will be unnecessary to consider it in its broadest sense, but more can probably be gained by treating of its special applications to certain fixed duties. Undoubtedly its greatest services are of the future, and we are probably but on the threshold of its greatest development. It is to be hoped that it will not be overrated by the amount of praise that has been bestowed upon it during the past few months. Paper has followed paper, and trade magazines and periodicals have vied with each other in their efforts to obtain new data regarding this interesting but not newly discovered power. The machine shop, boiler shop, the mine, the quarry are all largely using it. The street railways are investigating it with a promise of giving it at least a fair trial, and there are almost unlimited opportunities open for it in the domestic and light manufacturing field, only awaiting a public supply of both compressed air and of a more general knowledge of its advantages as a safe, elastic and convenient power. It is of its service in the foundry, and especially as a hoisting power, that this paper will treat. But before taking up the immediate subject at hand, it will be necessary to consider for a moment the adoption of air as a principal distributing power for all classes of foundry work. So wide are its applications in this line that one is tempted to see a foundry with no steam engine other than the one which drives the piston of the air cylinder of a compressor—unless, under favorable conditions, a separate steam engine be used for the blower. If the writer were to-day installing a foundry of, say, 20 to 50 tons daily capacity, the temptation would be strong to adopt com-

pressed air as the only transmission power. We are not aware that such an example exists in foundry practice, and can recall but one instance where this system has been adopted as the prime distributing power by a manufacturer in any line, and that one, the Weurpel Co., of St. Louis, was unfortunately short-lived, and afforded but little opportunity to show what could really be done.

The power problem of the foundry, however, seems to invite a ready solution by this system. The various power units are almost invariably widely scattered, and many times must be portable, necessitating a power easily distributed over a large area. In the average foundry the fan or blower is the principal item of power consumption for several hours during the day; and the power system, if tabulated, would result somewhat like the following, taking as an example a foundry of 30 tons daily output:

Blower		20 h. p. for	4 hrs	=80 h. p. h.
Mills and misc. power..........		6 h. p. "	3 "	=18 h. p. h
Hoisting..............	Average	5 h. p. "	10 "	=50 h. p. h

The last power item is intermittent in actual work, but the need of it extends throughout the day and calls at times for a much higher horse power than the above average, but generally a much lower amount of power is used. If the foundry is modern and progressive it will also use power for sand sifters, air chippers, cleaners, etc., and under special conditions other power machines would be desirable if air is used, when they might be impracticable under any other power system.

The predominant practice of the present time is the installation of one steam engine of sufficient power to meet the demands of the entire establishment, and the distribution is effected by means of line shafting and belts. In occasional instances electric motors are economically used for the distribution of the power. Frequently a separate steam engine runs the blower, while a system of shafting and belts attends to the balance of the equipment; but it so happens that the arrangement of an average foundry is such that power so applied is invariably on a most wasteful basis. Countershafts, clutches, bevel gears and combinations of

square shafts and worm gears (on cranes especially), all running for the entire ten hours, results in a tremendous waste of power; 50 to 60 per cent of the power is often used in turning the shafting alone, not to mention the loss resulting from the peculiar style of mechanism made necessary by the use of line shafts, and this friction loss goes on steadily throughout the day. This one item has furnished the electricians with one of their best arguments for the adoption of an electric motor system for driving the various tools and machines used intermittently, and the same claims can be advanced with added emphasis for compressed air. The writer recalls one instance of a foundry (or rather a group of foundries, melting over 100 tons daily) in which over 400 feet of shafting conveyed the power to the various widely separated machines, and 500 feet would probably be a low estimate of the amount of belting in daily service (and this does not include a rope drive or two) all in constant motion whether doing useful work or not.

With a compressed air system, using engines on each machine, power is used only while the machine is in operation. When it stops the consumption of air stops, and the air in the service pipe will stand idle all day if necessary; then when required it is instantly ready for service if even for a moment only. We all know how tempting the use of separate steam engines has been in the past, and that the principal objection to that system is loss through condensation. Their use on cranes has been curtailed owing to difficulties attending transmission of both live steam and exhaust. It is in this intermittent work that the largest item of saving records itself, and much of the power work of a foundry is intermittent. Especially does this apply to the various hoisting operations.

As stated above, the average amount of power utilized in hoisting will probably be about five h. p. for ten hours. This appears a low estimate, and it will seem lower when expressed in ton feet, but in reality it is a very liberal estimate if we take the power actually utilized. But in a belt power establishment it is more because so much power is consumed in turning the shafting and because power thus used goes on continually and not intermittently, as in a motor or engine system.

Let us consider in a general way what amount of hoisting is actually done in a machinery foundry of, say, 30 tons daily capacity. It will probably seem greater when represented in dollars and cents. We will assume that the iron and coke is unloaded by the wheel-barrow method, and will not consider that, nor indeed any work which does not require the service of either a hoist or a crane. Let us begin with the elevator. Modern practice places the charging floor from 16 to 22 feet above the ground. The entire 30 tons of iron must be hoisted this distance, so we have the daily hoisting represented, 30 tons x 18 feet = 540 ton-feet iron and about 4 tons x 18 feet = 72 ton-feet coke. The lifting of flasks, copes, etc., is more difficult to estimate, but as nearly as can be obtained by actual observation it will amount to an average daily lift of 500 ton-feet. Of the 30 molten tons of iron, 20 to 25 tons will be many times handled by cranes, and the various operations of shaking out, storing flasks, cleaning, loading and breaking castings represents 900 feet-tons more. This, in all, equals about 600 feet-tons for the elevator service and about 1,400 feet-tons for general crane service per day, or an equivalent of 2,000 tons hoisted one foot or one ton hoisted 2,000 feet. Of course this result would vary greatly with different kinds of work. A pipe foundry would show a much higher result and a foundry making light castings would show a smaller total, but we will take as our example a foundry whose hoisting represents 2,000 ton-feet daily, and this generally will be a 30-ton plant.

What is the best power with which to handle this material? The correct answer is that probably no one power is best adapted for all the various operations; but, assuming that one power is to be used, it seems to the writer that compressed air is the most available.

Mr. Richards asserts that compressed air costs about five cents per 1,000 cubic feet of free air. This is the basis usually taken in making estimates, and at first thought it seems to be very cheap, but with a modern four-stage compressor the cost will be much less; in fact, in some cases it is difficult to see how the cost per 1,000 cubic feet of free air can reach four cents, including depreciation, repairs, oil, fuel, interest and miscellaneous items.

Assuming five cents, however, as a basis, the power cost of lifting one ton one foot, in a direct acting air hoist, is about .0007 of one cent, or to put it on a more comprehensive basis, seven cents per 1,000 ton-feet. We have already seen that the average amount of hoisting in a foundry of 30 tons daily output was 2,000 ton-feet so the power cost of doing this work, including power repairs, power labor, fuel, oil, interest, etc., is not over 14 cents per day. The operating labor is to be added to this to estimate the total cost of hoisting. (In these calculations the hoisting is alone considered, and we may assume that lowering is done as cheaply by one power as another.) In order to obtain the operating labor cost we must first obtain the speed of hoisting. We have made a series of tests with hoists ranging in diameter from 4 inches to 16 inches, and in capacity 600 pounds to 6 tons. On small hoists the valve ports were approximately of inch 1-10 area, on larger hoists some were of this area, others of 1-5 inch area. The speed of hoisting varied from 25 feet per minute in six-inch hoists, fully loaded, to six feet per minute for six-ton hoists. The average speed was found to be not far from 20 ton-feet per minute. Of course under high pressure this would be increased, but the object was to find a safe average speed for normal service.

Taking this on a basis of 2,000 ton-feet per day, assuming the operator's labor at $2 per day, we have an operating or attending labor of about 25 cents per 1,000 ton-feet. The total cost, therefore, of hoisting one ton 1,000 feet will be about 32 cents, or in a foundry of 30 tons daily capacity about 65 cents per day, using direct-acting vertical air hoists. If geared hoists are used the amount of air necessary to lift a ton-foot will be increased and the power and operating cost will be more nearly represented by 90 cents per day.

Here we may call attention to the fact that the ordinary vertical direct acting air hoist is one of the most efficient hoisting machines in use. It utilizes in useful work fully 85 per cent of the power delivered to it. Few geared hoists, electric, hand, air motor or steam, have a higher efficiency than 60 per cent. Some electric cranes show a loss of 65 per cent in friction, or 35 per cent efficiency, although the average efficiency of the electric crane

gearing is perhaps nearer 50 per cent. The average differential or worm-geared chain-hoist has 30 to 40 per cent efficiency and the cost of operating, measured in time and wages, is immense.

For the purpose of comparison, assume the foundry mentioned above to be equipped with hand-power cranes. The average speed of hoisting by hand-power, using one man, is about one ton hoisted two feet per minute. For short time work it is a little greater, but for steady work it is less, and on chain blocks o. worm gearing it is not much more than one ton one foot per minute. At a "two-ton foot rate" it would cost by hand-power $2.50 per 1,000 ton-feet, against 45 cents per 1,000 ton-feet for air hoists doing the same work. Or, roughly, in a 30-ton per day foundry, $5 per day represents the labor of hoisting by hand-power against 65 cents to 90 cents per day by air hoists—a saving well worth considering. It may be pointed out that this saving would be equally great when using other mechanical power than air, but this would be true only when applied under certain conditions, as for instance, handling uniformly heavy loads, and even then, as indicated, the power item would be 40 to 50 per cent greater, owing to the low efficiency of the geared machine as compared with a direct acting vertical hoist.

Another advantage of the direct acting air hoist is the wide variation of speed obtainable by the simplest possible means and involving practically no waste of power. With a fixed load the speed will vary automatically with the size of the port; and with a fixed port opening the speeds will vary with the weights lifted. The area of the port opening of the valve may be controlled in the usual manner by the distance the valve is opened, or in the best valves a throttle is provided independent of the main lever, and this being fixed for a given port opening, the valve may be thrown fully over. This device will be appreciated by any one who has attempted to control the port opening on a hanging hoist by pulling on cords attached to the lever.

Thus far comparisons have been made with the direct acting or "cylinder" hoist, which is essentially a cylinder of cast iron, or steel, or brass, accurately bored and polished inside, and fitted with a piston and piston rod, and to the latter is attached a hook,

and on the cylinder a hook or ring is provided for attachment to the trolley or beam overhead; the cylinder thus hangs vertically and the load is lifted by the admission of compressed air on the under or "piston rod end" of the cylinder. This is apparently a simple machine, but if accurate or efficient work is desired great care and experience is necessary to properly construct it. Once properly made it is easy to take care of, its parts are few and not subjected to much wear, and are cheaply and easily replaced when worn. A poorly designed hoist or one cheaply constructed is not a good investment.

This cylinder type or direct acting hoist is capable of a number of modifications. The cylinder, with its heads and piston, its hooks and stuffing box, occupy considerable space vertically and require usually a fairly high ceiling. This should be borne in mind when selecting the hoist, for a very common mistake is that of choosing too long a stroke for the ceiling space. The distances to be added to the stroke to get the total length between bearing points of hooks when hook is lifted to its highest point (or to be added to double the stroke when hook is extended, to secure length over all) range from one foot in the small 4-inch or 5-inch hoists to two feet in the 16-inch to 20-inch hoists. If a swiveled hook is used these dimensions are increased about 50 per cent. Many times a long stroke is asked for when a short stroke would do as well; there is no advantage in this, and it is usually unsatisfactory because it really increases it. Probably the foundry of the future will have its very lowest ceiling not less than 20 to 25 feet high, because vertical air hoists will become so essential that their influence will assert itself upon the architecture of the plant. Horizontal cylinders may be used in exceptional cases where vertical hoists cannot be used, and these are constructed in a variety of forms. The cuts Nos. 4 and 5 shown in plate A illustrate one type, and they may be applied to cranes in numerous ways. No. 3 shows another method of securing a high lift in a small head space. Other special applications of air hoists are also illustrated. No. 1 shows a hoist supporting a long operating cylinder upon its piston, designed for grappling. Two cylinders may also be readily combined for tipping a ladle or dumping a

bucket by somewhat modifying this design. No. 2 illustrates a vertical storage hoist designed by Mr. Fisher of the Griffin Wheel Co., and used in its plant. The ordinary vertical hoist is surrounded by a small receiver, and when traveling a considerable distance and the load is to be lowered and another load raised, air is taken from the receiver for this purpose. This is applicable to locations where a hose cannot conveniently be carried. Wherever an air cylinder can be used, however, whether on cranes or elsewhere, it is desirable to use the vertical direct acting type, because it is more easy to operate, is higher in efficiency, and hoists with a more even and smooth lifting motion than do horizontal or other types.

The elasticity of air when used in a direct acting hoist is well known and is many times an advantage. In a well-made hoist properly cared for, the lowering of the load due to leakage is not sufficient to cause trouble. A uniform load may be held usually for several minutes at any point without perceptible drop. If it is desired to hold the load for a longer time, this may be accomplished by raising the piston to the top of the stroke and leaving the air pressure on; or by adjusting a slipping or pinching collar on the piston rod the load may be held by air pressure at any point. The raising of the load when pouring metal, due to expansion of air in the cylinder, is generally an advantage, obviating the necessity of hoisting the ladle as it empties by opening the valve. If the rise is too great, a little air may be released. For certain special duties some hoists have been equipped with automatic release valves, others with slides and valves which automatically open for the admission of air to compensate for leakage and for the release of air when the load rises. An automatic means for closing the valve at top of stroke is serviceable in saving air and is assumed in the calculations in this paper.

When applied to cranes, positive action of the load may be obtained by the use of a water reservoir between the air pipe and the hoisting cylinder, with a regulating valve between reservoir and hoist. The hoisting cylinder then becomes practically a hydraulic hoist and should be constructed as such. The whole appliance is essentially a hydro-pneumatic hoist. The speed

may be perfectly controlled by the regulating valve, or the load may be held indefinitely by closing this valve. An appliance of this kind is of course open to the same objections that are advanced against a hydraulic hoist, especially in an exposed location subject to a freezing temperature. This may be overcome, in a measure, by the use of oil or an anti-freezing mixture in the reservoir. The hoisting cylinder may be placed horizontally with the reservoir below it, but there is less friction and better results generally obtained from a vertical cylinder.

There are numerous places where a direct lifting hoist cylinder, either vertical or horizontal, cannot be used. Scant head room, short spans or jib of cranes, and occasionally a demand for a perfect or positive action without the elasticity of direct pressure, sometimes prevent the use of hoists of this character. It is here that the geared or air motor type finds its field of usefulness. We are all familiar with the modern three-motor electric crane and with the well-known steam jib crane so generally employed in pipe foundries. Undoubtedly the electric crane owes its popularity largely to the ease of transmitting the power from a fixed point to a moving machine. Until its appearance, the power traveling crane in general use was either belt or rope driven or operated by a square shaft. The power was subdivided and reversed by an intricate system of clutches, bevel gears and frictions. No one would now think of returning to that "all day" fuel consuming method unless the crane travel was exceedingly short, or the conditions much more favorable than usual. The electric crane offered emancipation from such systems, in the form of independent motors for each function, an easy method of reversing, and a consequent minimum of mechanism, outside of the motor, a variety of speeds and a simple and highly efficient method of transmission.

The three-motor compressed air traveler possesses all these good points, with the addition of lower first cost and greater simplicity. With a proper pipe-line the transmission loss is less than in electricity. The engines are as simple as those used for steam and may be easily reversed and controlled. Rheostats and expensive controllers are not needed; and the speed is reduced

by throttling and saving the power rather than by consuming it. The valves may controlled as easily from the floor of the shop as from a cab—a feature well worth consideration in a shop of limited output where a crane man's time in a cab is a serious item of expense. The half-tone cut on opposite page shows a 10-ton air motor crane operated from the floor. This crane was originally designed for operation by electric motors, but at the last moment air was substituted with equally good results. The air engines were applied in the same manner that electric motors are, and owing to their compact form the air crane trolley is much smaller than the electric trolley. A muffler is provided, making the crane operate with as little noise as when operated by electricity. The span in this case is so short that travel of the trolley is effected by a pendant hand chain, and a cab was not considered necessary. In certain classes of foundry work a number of these cranes (one for each group of molders, for instance) running on a series of parallel tracks and operated by the men on the floor, would undoubtedly possess many advantages over a single traveler of long span attempting to cover the entire foundry floor. The speed of travel and hoisting may be made as high as in an electric crane, the power of the engine employed being the only limit to the speed.

The air is usually carried in a rubber hose. The slack of the rope is supported by a number of small trolleys riding a taut horizontal wire along the crane runway. The hose connection is made at one end of the runway and as the crane travels out it simply pulls the hose after it, and when it returns the hose is pushed before it, folding back against itself as the trolleys are pushed together. We have carried air in this manner a distance of 250 feet without the slightest trouble. The beauty of this system compared with other hose systems is the absence of couplings and connections and the consequent small opportunity for leakage. Sometimes when the travel is long, several wires are used, each supporting a separate trolley. The connection between the main supply pipe and the hose may then be made at any point along the track, for the trolleys can pass each other. The hose

in all cases should be amply large, three-quarters to one and one-half inches, depending upon distance, and three to four-ply of good quality.

Air engines may be applied to jib cranes, elevators and other hoisting machinery with equal ease. They may be applied to the travel gearing of a crane with relatively equal saving as when applied to the hoist. Compact reversible engines may be readily and cheaply applied to present hand-power cranes without materially changing the design, and the crane may still be operated by hand power at times when the power plant is not in operation. Air may replace steam in engines now in use on steam cranes. It is somewhat remarkable that founders making cast iron water pipe have not long ago adopted compressed air as a crane power. The conditions are peculiarly well-suited for air; excessive heat, dust, smoke, intermittent work, and widely scattered machines in foundries of this class all offer it an inviting field. At present many of these foundries are operated by steam jib cranes, which could easily be converted into air driven machines. Some of the more recently built pipe foundry plants have installed electricity on traveling cranes, but if there is any place where air would be emphatically advantageous it is in these shops. With steam there is a great loss through pipe condensation, and the already heated air is rendered further uncomfortable by escaping steam and heated engines. Compressed air could be exhausted directly into the atmosphere of the shop and would assist in some degree in cooling and ventilating. There would be practically no loss in the pipes, as compared with steam. Air is a humane power. It does not hurt a man if he is struck by a jet. It doesn't make him uncomfortable. It is the most pleasant of all transmission powers to handle and the most convenient to subdivide.

The application of air motors also, to the gearing of existing hand-power cranes, would result in a large annual saving; it would in many cases pay for the investment in less than one year after installation.

In the consideration of compressed air for operating a hoisting plant, the question of efficiency will at once suggest itself. There is a much discussed loss of power in the compression of air, the

importance of which may be great or small, depending upon the conditions. These should always be considered, and the question of availability and economy should be looked at practically as

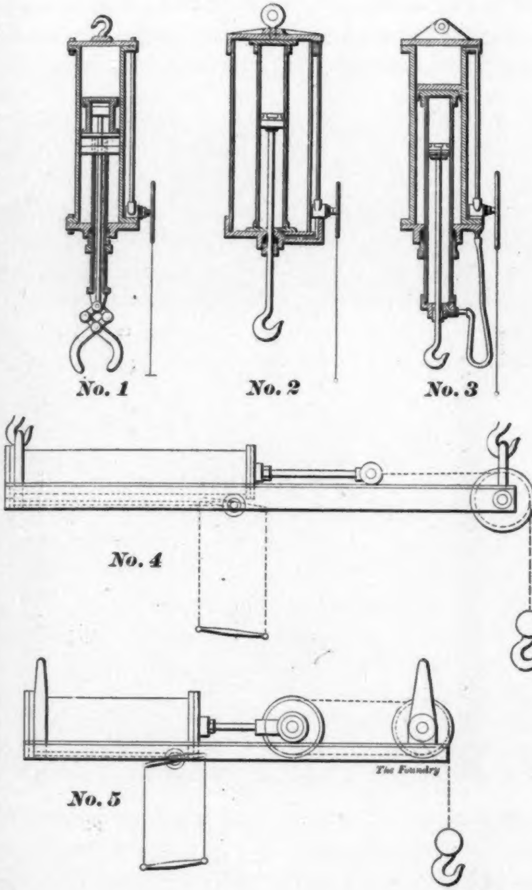
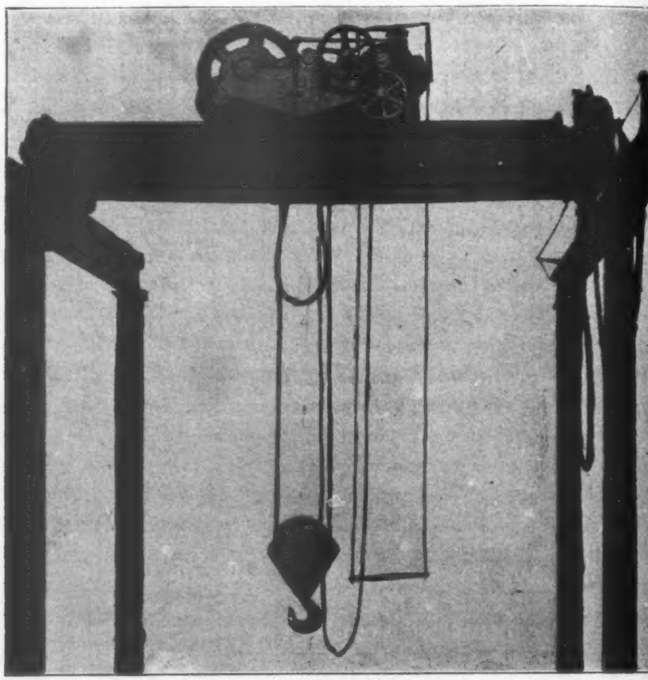


Plate A

well as theoretically. It will be well to remember that all systems embody power losses, some greater and some less than the power here under consideration, and many actual examples may be

pointed out in which even electricity as a hoisting power is less efficient mechanically than air. And it is doubtful if one-half of the belt power or square shaft cranes in use will show as great economy in the use of power as a well designed air crane, without considering the large waste due to continuous motion of transmission parts, whether doing useful work or not. When the ques-



tion of absolute saving in dollars and cents at the end of the year is considered, there appears in many cases a decided balance on the side of air. When using a direct acting hoist system, with a hoisting machine efficiency of 85 to 90 per cent, a higher net efficiency for air than for electric or any other modern and practical shop power can be claimed with reasonable assurance. Using a mixed system, hoisting about half by means of geared hoists

and half by direct cylinder, we may claim fully an equal efficiency with an electric geared hoist system. And using an air motor crane alone, as compared with electric motor, although probably a less power efficiency is obtained, a higher economy, investment considered, may in many cases be safely claimed.

If the power at the steam engine of the plant is taken at 100, and if we deduct, first: Percentages of loss for engine and dynamo (or engine and compressor), as generator loss; second, wiring, piping, or belting as transmission loss; third, the loss in motors or air engines, or clutches, as power transmitters to the gearing; and, finally, the friction loss of the hoisting gearing itself, we will find but a small percentage of the initial engine power has been expended in useful work. While the conditions vary greatly, we may make a reasonably accurate comparison on a maximum load basis which would show the percentage of power expended in useful work to be as follows: Using electricity as a transmission power, with geared hoists, about 30 per cent; using system composed of half geared drum hoists, 24 per cent; using system composed of half geared hoists and half direct hoists, 35 to 40 per cent, and using all direct hoists, 50 per cent. Of course, when handling lighter loads the efficiency would be less. Such results surely do not make a bad showing for air. There is undoubtedly a fair saving power in favor of the electric motor crane alone, but this showing of increased efficiency for electricity does not mean necessarily a greater annual economy; and a reduction to dollars and cents involves considerable of items like interest on investment, care taking and operating labor, every item of which shows a gain for air. Here is a difference between efficiency and economy. A machine may be highly efficient mechanically and still be comparatively uneconomical financially. An electric crane costs more than an air crane, and the interest on the difference in first cost will generally amount to more per annum than the saving in fuel due to the higher efficiency. It is our belief that the three-motor air crane, for instance, would not represent a greater expense per annum, investment considered, than a three-motor electric crane of the same size and capacity. Making a comparison with hand power, as already stated, the

cost of hoisting by manual labor in the foundry under consideration would be not far from $5 per day, equivalent in good times to $1,500 per year. By air it would cost $200 to $250 per year, or, if we include interest on the investment, which is only fair, we will have a hoisting cost, when operated by hand power, of about $1,600, against $380 to $480 using air. The saving would go far toward purchasing a first-class air plant.

A further comparison with steam, hand, belt or electric power would call into consideration various conditions under which sometimes one power and sometimes another might be the most available or expedient. It is not our intention to in any way decry the use of electricity or other power when conditions undoubtedly recommend the use of either. It is our aim, however, to call attention to a power which has hitherto been largely left out of consideration as a shop transmission power and which, in our belief, fully deserves consideration on its merits. It is undoubtedly more economical in many cases than either of the other powers mentioned, and in numerous instances more efficient mechanically; in nearly all cases it is the most convenient.

Consideration of compressed air, aside from its use as a hoisting power, is outside of the province of this paper, but since reference has been made to its exclusive employment in a plant, the subject of its availability for other purposes in foundry practice may be briefly noted. As already shown, the greater amount of power in the ordinary foundry is required to operate the cupola blower. In an imaginary foundry operated exclusively by compressed air, this blower, even if located at a distant point from the boiler, could be readily driven by a direct connected air engine provided with an inexpensive reheater, at an economy equal to, and many times greater than that obtained by a steam engine directly attached.

There are well-known advantages in operating a blower by an independent engine using either air or steam, the principal one being the ease with which change of blower speed may be effected.

In plants having the blower located close to the boilers, steam could be used advantageously in the engines and the air compress-

ing plant be correspondingly reduced in capacity. The tumblers could be readily operated by motors, and here the exhaust could be also utilized. Sand sifters, portable or otherwise, are more readily operated by air than by any other power. A small hose, with a nozzle attached to overhead joists, serves as an unexcelled bellows for dusting molds. The air chipping tool and pneumatic sand blast promise improvement in the work of cleaning castings, and the castings may be readily broken by pneumatic drops. In many cases it has been found advantageous to weaken a heavy casting by drilling a line of holes in it with a portable air drill, after which it readily succumbs to the blows of the drop. The advantages of an air elevator are covered by our reference to general hoisting.

These are a few of the many diverse applications of air in a foundry which readily cluster around an air hoisting plant.

It may be advisable here to offer and repeat a few suggestions as to the proper care of such a plant, especially that portion of it relating to the hoisting appliances. The foundryman must not get the impression that all he has to do is to have the machinery installed, and that it will operate without further care or attention. Compressed air has no special privileges. Its components are not exempt from those laws that govern other elements, and knowledge of this at the start will often save trouble later. For instance, air has an advantage over hydraulic power in exposed locations, because it will not freeze; but if the pipes are improperly installed, the heated air will deposit water which will collect in inviting places and freeze as readily as any other water. This may be avoided by properly draining the pipe line, or in particular locations, protecting it. Leakage is another item easily avoided if the plant is carefully installed. Large pipes should be used—one and one-half to two and one-half inch mains, the larger the better, with smaller connecting pipes. The receiver should be frequently drained and an occasional "U" in the main, with a drip and cock at the bottom, will keep the pipes free from moisture. More than one receiver may often be advantageously used in a plant of large dimensions with intermittent work, one at the compressor, and others near the point of direct service. Re-

heaters on motors yield undoubted economy when used on a machine operating continuously for several hours. On cranes used infrequently, or on other intermittent work, it is doubtful if they would show much gain unless used in connection with an automatic attachment which partially turned off the heater while the motor was not operating. On cranes used almost continually, as in pipe foundries, a reheater at each engine would bring the air geared hoist very near, if not above the electric hoist in mechanical efficiency. Direct acting cylinder hoists should be kept well oiled. A good quality of "neatsfoot" oil has been thus far found most suitable for preserving and softening the packing used in the pistons. Oil should not be allowed to get onto the rubber hose, unless a specially prepared hose is used; it causes it to decay. The pipe line, when first installed, should have all dirt or dust blown out before attaching it to the machines. An air-hoist should be loaded and copiously oiled, and raised and lowered several times when first put into service to get it into good working order. A pressure of 60 to 100 pounds has been found most convenient for general use.

Briefly summarizing, air is undoubtedly a most convenient power to subdivide into many hoisting units, and when so used shows high mechanical efficiency, and a large saving in handling products. It is more easily applied to geared traveling or jib cranes than either electricity, steam or belt power, and compares favorably in mechanical efficiency with either, and is in many cases actually more economical than either when so used. It is easily installed, of comparative low first cost, and can be taken care of by an ordinary machinist. It is handled without danger, and therefore is an ideal portable power. It is worthy of serious consideration not only as a hoisting power, but as the exclusive transmission power of the modern foundry.

At the conclusion of these papers the meeting adjourned until the evening session.

At 7:30 p. m. the members and guests sat down to a banquet at the Great Northern Hotel, after which the President called the meeting to order. Among other things Mr. McArthur said:

We were somewhat disappointed when it became apparent

that, owing to local disturbances at Cleveland, we would not be able to hold our meeting there as originally intended. But the edge of disappointment wears entirely away with the splendid papers we have heard this afternoon and the proposed discussion thereon to-night, and I do not think that our September meeting has been a failure in any sense.

A. Sorge, Jr., complimented the association upon the progress it had made, and the fruit borne by the technical lines taken up by the foundrymen.

Mr. Shields spoke on the economy of compressed air, enlarging upon his paper of the morning session.

At this juncture a general discussion on air and sand blast was indulged in by Messrs. Carver, Ferguson, Sorge, Armson, Patten and others.

Mr. Johnston thought the greatest danger in the installation of a compressed air plant was to put in a compressor that was too small.

Mr. Shields, at the request of Mr. Sorge, explained how he arrived at some of his conclusions and how he obtained the data contained in his paper.

The thanks of the association were extended to Mr. Shields and Mr. True, whereupon the meeting adjourned.

A REVIEW OF THE FOUNDRY LITERATURE OF THE MONTH.

AMERICAN ENGINEER AND RAILROAD JOURNAL

Has an interesting table upon cast iron car wheels, and shows what wonderful strides have been made in this line during the past decade, the greatest honor for which must ultimately be placed to the credit of the foundry. The length of life of a modern car wheel is somewhat surprising; hanging on with tenacity after traveling more than one hundred and fifty thousand miles; carrying loads nearly double that of former days.

AMERICAN MACHINIST

In its issue of September 3, contains a few more hints on the use of molding machines by F. O. Farwell. They are timely as showing that present practice lays in the direction of making all molding machines movable to avoid unnecessary handling of materials. This applies to places where such handling is done by hand labor. Where a system of conveyers is in use we believe that the stationary machine has the advantage, especially where power transmission is considered.

September 10.—L. C. Jewett has something to say on the dampness of green sand and the way of overcoming the effects of such in complicated molds. It contains suggestions that should be retained by molders and foundry foremen in general.

September 24.—The same author and W. E. Malpass each contribute their opinions on "Invention in the Foundry." Both arrive at the conclusion that as inventors the foundrymen, whether foremen or molders, are not near as far behind as generally supposed, but that most of the every-day inventing done in the foundry remains outside of the knowledge of those least acquainted with actual conditions.

ENGINEERING

Engineering, in commenting upon the ridiculous conditions to which imported cast iron water pipes were being subjected before they were accepted by the authorities at Tokio, states that the Tokio city council has instituted a civil suit against the officials of the Tokio Iron Foundry for damages amounting to 1,003,-543 yen. The accused are charged with causing loss to the claimants by supplying defective pipes to the amount of over a million yen, inclusive of interest at the rate of 6 per cent upon the money disbursed by the council on each occasion of the pipes' delivery, that being the rate at which the city floated the water works loan. From the epitome of the finding of the Tokio Preliminary Court in the case, it is evident that while the Japanese are showing that they know how to apply science to legitimate purposes, some of them take the opportunity of using it for purposes of fraud.

In January, 1893, the Tokio Iron Foundry Company succeeded in concluding a contract with the Tokio city council to supply, at a certain price, water pipes to the extent of 21,335 tons. According to the conditions of the contract, the company undertook to deliver the first installment of pipes, weighing 2,000 tons, within two months from the date of signing the contract. Finding it impossible to fulfill the terms of the contract, the company submitted a petition to the city council, and obtained permission to reduce the quantity of pipes to 10,000 tons, to be delivered in eleven installments, one every two months, between June, 1894, and February, 1896. Arrangements were stipulated for the adequate testing of the pipes. The stages were, first, analysis of the material to be used; secondly, examination of the general character of the casting; thirdly, measurement; fourthly, weight; fifthly, pressure. A large pipe of 43.3-inch diameter was to be tested to a pressure of 150 pounds on the square inch; and a smaller pipe from 3.39 inches to 9.84 inches to 225 pounds on the square inch.

It is stated that want of experience on the part of the company's experts and artisans made the work of casting the required quantity of pipes one of unexpected difficulty. Out of sixty-seven large pipes, of 43.3 inches, cast between October, 1893, and January, 1894, fifty-nine were rejected either on account of defective

casting or of wrong weight, while out of the pipes subjected to the pressure test, only one out of five was judged perfect. Instead of applying their ingenuity to the improvement of the methods of casting, those in charge turned their attention to the manipulation of the pressure gauge of the hydraulic testing machine, and succeeded in making it show a pressure of 150 pounds when the actual pressure was only 100 pounds on the square inch. The result was an apparently rapid improvement in the quality of the pipes, and from January, 1894, to June, 1895, a considerable quantity was delivered.

Emboldened by their success, the foundry officials commenced to use up the pipes which had formerly been rejected by renewing the marks and changing the numbers. The gauges of the machines for testing the smaller pipes were treated in the same way. One was made to indicate 255 pounds and another 300 pounds on the square inch, although the actual pressures were only 140 and 160 pounds respectively, and by these and other means, they were able to pass a large number of the smaller pipes which had formerly been rejected. The Preliminary Court made a most thorough investigation into the whole circumstances, and their finding gives a minute account of them and of the responsibility of those in charge, and it will be submitted to the judgment both of the civil and criminal courts. The whole case is of considerable interest to British pipe manufacturers, who ought to make themselves acquainted with all the conditions under which they are expected to compete for Japanese contracts. It is to be hoped that the Japanese will also take to heart the lessons to be learned from it, and not throw away their money on undertakings which they are not able to carry out successfully on account of deficient experience. We regret to see that a Japanese professor in the university is mixed up in the scandal. Hitherto those who have attained such a position in Japan have jealously guarded its honor, and we hope that the case we have mentioned will long remain exceptional.

(This goes to prove that the Japanese must learn by experience as well as the Americans, and shows with what rapidity even savages learn to doctor a bad casting.—Ed.)

THE FOUNDRY

Contains from the pen of E. Grindrod some timely suggestions on the charging of cupolas. The author calls attention to some irregularities in ordinary practice, particularly in charging and in the indication of blast meters.

H. M. Ramp reviews some former articles on cupola practice, and along with his own extended knowledge in this line manages to present an interesting paper.

Mr. W. J. Keep, in his cast iron notes, furnishes a very exhaustive exposition as to how carbon is absorbed by cast iron. It is stated in such plain language as to leave no excuse for anyone being ignorant in this respect, and is one of the most instructive chapters in metallurgy that has appeared of late.

James A. Beckett advances some practical ideas in regard to match-plates and patterns, specially seasonable at this time, when much work that has hitherto been made, as loose pieces or gated patterns, is being transferred to the match-plate for a more rapid production.

In this issue several firms have advanced samples of their foundry record sheets, giving the reader direct benefit from actual working sheets, whereas much that has heretofore been published on this subject has had its foundation merely in theory.

Other notable essays are forwarded on "Making Clean Castings" and "Mending Broken Castings."

MACHINERY

For September has a well illustrated article on the Watertown Arsenal, contributed by Maj. J. W. Reilly. A brief description of the foundry is included, enumerating its equipment and ending with a view of the foundry, showing the casting of practice shells.

IRON TRADE REVIEW.

In its issue of September 3, publishes an article from the advance sheets of Mr. Thomas D. West's new work, "The Metallurgy of Cast Iron." The author has been so prominently before the foun-

drymen in the past and all of his writings have been so universally read that his forthcoming volume will need no recommendation to secure its introduction. In the present instance Mr. West speaks as follows on

"The Use of Direct Metal for Founding."

In the first days of founding castings were made from metal, taken directly from the furnace making the iron. The difficulty and uncertainty of obtaining the grade of iron desired, and the fluidity necessary to insure good work, as well as the advantage of having metal when best suited to the founder's needs, led to the invention of the cupola to remelt iron. Had the furnace advanced anywhere near the degree in assuring a uniformity of "grade" that it has in increasing its output, many more castings would be now made direct from furnace iron. While many may question the ability of the furnace to ever achieve any better results in always obtaining a uniformity of product, competition will strongly influence an effort for improvement in this direction. Aside from the above evil is the trouble caused by the "kish" found with metal high in graphite, as high grade irons. Often after a furnace "cast" of foundry or Bessemer will the floor of the house be covered with "kish," which in appearance resembles flakes of silver lead or plumbago, and is the same flaky carbon material so often found separating the grains of pig metal and castings. It can be removed from fractures by means of a still brush or rubbing.

The evils to be expected from metal possessing much "kish" are mainly in "cold-shuts," spongy, porous spots in castings, and a separation of the metal's grain at places where "kish" might be confined. One might as well try to make a union of oil and water as of "kish" and cast-iron. Were it possible to collect or skim off all the "kish" in high grades of direct metal, little damage might be expected; but this is not practical, as the "kish" keeps rising to the surface as long as the metal is in a fairly fluid condition. Appliances have been invented with a view to collecting the "kish" in pouring runners, etc., before the metal would enter the molds, but these have proven of little value. It may be said that metal possessing much "kish" is unfit for pouring castings.

Direct metal free of "kish" can make very good castings, and for some classes of work might often prove more desirable than cupola iron, as less sulphur can be obtained in direct metal than with iron remelted. Iron cannot be remelted in the cupola without increasing its sulphur from 10 to 100 points. Remelting of pig metal entirely destroys the "kish" that appears with direct metal.

The life and fluidity of direct metal, compared to cupola iron, are qualities many will question. If a furnace is working properly its product will compare very favorably, as regards these qualities, with cupola iron. The writer has seen hotter iron from a furnace than was possible to be obtained from a cupola and keep its life or fluidity exceptionally long. In fact, the author is of the opinion that direct metal can have such an initial heat imparted to it as to create a much greater life to the fluidity of the metal than can be obtained in remelted iron.

To utilize direct metal, some have thought it would be a good plan, in order to overcome the difficulty from "kish" and obtain more uniform product, to first pour the metal coming from two or more furnaces into a large receiver or reservoir so arranged as to closely confine from 50 to 100 tons of iron, the idea being that if the metal should have "kish" in one furnace, another would be free of it to mix with it, and hence an average could be obtained which would be sufficiently free from "kish" to obviate any defects in the casting. The information which the writer has obtained as to the success of this plan is not very favorable. The difficulty found consists in the iron losing its fluidity and life too much by the extra handling and detention of the metal in the fluid state. Where work is very massive, not requiring good "hot iron," this reservoir method could be of much value, but the difference which exists in the cost of direct metal and cupola iron does not warrant any very great chances being taken in losing castings on account of the fluidity and uniformity of a "grade" not being as desired. With work that involves little risk, however, "direct metal" in these days of close margins may command attention in some cases.

It is no uncommon thing for us in our foundry to make small castings with direct metal carried by three men in a "bull ladle" taken from a furnace close by us. The plan which we adopt in obtaining such small bodies of metal is simply to catch the metal with a "hand ladle" by dipping the iron out of the main runner as it flows to the pigs and pouring it into a "bull ladle." We have made very good small castings by such a plan. We have also taken "direct metal" in crane ladles, by having a car run on a track, sunk sufficiently below the level of the main runner to receive the metal from a branch runner extending out beyond the casting house. With iron containing silicon below 1.50 and sulphur above .030, it is rare that any "kish" is seen, and when such direct metal can be obtained very good castings can be secured. Of course, with such low silicon and high sulphur iron, it is not to be expected that any work below one inch in thickness, requiring any great finishing, could be satisfactorily obtained, but for bodies above one inch in thickness very little trouble should be experienced as long as the metal does not get too low in silicon or high in sulphur.

It is the changeable character of silicon and sulphur which alters the "grade" in the product of a furnace as long as it is running on one class of ore, flux and fuel. Could the sulphur and silicon be controlled in or out of the furnace so as to have the liquid metal always possessing its metalloids constant, the present great objections to the use of direct metal in making castings would be removed.

To eliminate sulphur or silicon, etc., from direct metal is causing much labor and study in order to obtain, if possible, means to achieve success in this line. One method at present being conducted is that of Mr. E. A. Uehling, patented in papers No. 543,-115, granted July 23, 1895, in which the principle involved is to suspend a large revolving ball of certain materials in a ladle of liquid metal that may have an affinity for whatever metalloid is desired to be reduced or eliminated. At this writing the author is informed that the Sloss Iron & Steel Co., of Birmingham, Ala., is fitting up to give Mr. Uehling's plan a practical test. To give

an idea of Mr. Uehling's method in applying elements having an affinity for the metalloids, we present the following extract, which is taken from his patent papers:

"According to the nature of the elements of which the revolving bodies are composed and the end to be effected, these bodies are assimilated by the molten metal, or absorb from the same injurious elements, forming a slag, which separates by gravity from the body of the metal, rising to the top, where it can be removed. For example, if the revolving body or bodies are composed of carbon, and the molten metal which is agitated by them is deficient in the element, it will be absorbed and assimilated by the metal. If the revolving body is composed of silicon, manganese or aluminum, these elements will first satisfy their affinity for oxygen and the excess will be assimilated by the metal. Manganese has in addition to its affinity for oxygen also a great attraction for sulphur and is very efficient in separating this most injurious element from the metal thus treated. If the revolving body is composed of oxide of iron in connection with other basic material, the silicn will be removed from the metal bath, and under favorable circumstances also the phosphorus."

As Mr. Uehling has been very successful with other improvements which he has made toward advancing blast furnace work, we have every reason to believe that he will meet with success with the above apparatus for the elimination of what metalloids he desires to control.

Since writing the above I have been informed that Mr. Uehling is meeting with much success and has reduced silicon from 2.85 down to .67 and phosphorus from .65 to .47 at the Sloss Iron & Steel Co.'s plant. There is no doubt that sulphur can also be easily eliminated. It is hard to predict what changes in founding this process may make in carrying us back again, with many branches, to the old day of using direct metal.

IRON AGE

The Iron Age of September 3 has the following on The Manufacture of Charcoal Pig Iron Low in Phosphorus:

H. Tholander observes in the Jernkontoret's Annaler that at present pig iron low in phosphorus forms an important article of

export from Sweden. To obtain a satisfactory price, the iron must not contain more than 0.025 per cent of phosphorus. Still better prices can be obtained when the percentage of phosphorus is guaranteed not to exceed 0.020 per cent. In the making of very gray pig iron all the phosphorus that is contained in the ore, limestone and charcoal passes into the iron made. By careful analysis it is possible to calculate with a fair degree of accuracy how much phosphorus will pass into the iron from the ore and the limestone. It is different, however, in the case of charcoal, the percentage of phosphorus in which is very variable. It differs with the neighborhood from which it is obtained; it is different in hard woods to what it is in soft woods, and different not only in the wood of different ages, but it varies according to whether the wood was or was not barked. It is not possible to keep all these different kinds of wood apart from each other, and to obtain a true average is quite impossible. As a general rule, it may be taken that charcoal will cause an additional percentage of 0.015 of its weight of phosphorus to pass into the pig iron. Assuming that it is desired to obtain a pig iron with not more than 0.020 per cent of phosphorus, it follows that from the ore and limestone taken together not more than 0.005 per cent of phosphorus must pass into the iron. It is not, however, possible even to calculate on so low a percentage of phosphorus from the charcoal as 0.015. If it is a question of producing a pig iron particularly low in phosphorus, it is best to carefully sift the charcoal, and keep the smalls for other purposes, these smalls being relatively rich in pieces of bark, which, as is well known, is particularly rich in phosphorus. But even when using the same ore and the same charcoal, different results may be obtained by variations in the working of the furnace. A very gray pig iron made from the same ore charge by the use of 10 per cent more charcoal may contain some 0.005 per cent more phosphorus than the metal produced from the same ore charged with 10 per cent less charcoal. The easier a charge melts the more readily can a pig iron low in phosphorus be produced; consequently a red hematite with 50 per cent of iron and from 0.007 to 0.009 per cent of phosphorus is relatively good for use in the manufacture of a gray pig iron low in phosphorus. Un-

fortunately, these ores are rare, their usual percentage of phosphorus being from 0.018 to 0.030. Magnetites, too, differ greatly in their furnace value for this purpose. Ores containing manganese differ in this way from those which contain none, and the reducibility and fusibility also differ with the structure and composition of the gangue. The basicity of the charge is also of importance. The percentage of charcoal used will increase with the percentage of the lime used for pig irons of the same percentage of carbon, and the more charcoal there is used the higher will the percentage of phosphorus be that passes into the pig iron made. More limestone must not be used, therefore, than is necessary to keep the percentage of sulphur down within the desired limits. The preparation of a basic slag, by the addition of more limestone, is not particularly important, as when gray iron is being made its power of absorbing phosphorus is not particularly large. If, however, the ore is self fluxing and yields a basic slag, then the result is better, the slag retaining more phosphorus. As a general rule the furnace manager can do but very little to change the percentage of phosphorus in the pig iron if it is to be obtained from definite ores, and is to have a definite percentage of carbon. It is then rather just what the ore, limestone and charcoal make it. The charcoal should, however, be kept well sheltered from the action of rain and snow, and should be thoroughly sifted before use, and the wood should have been barked before use for charcoal purposes. Very gray iron, as has been pointed out, may be higher in phosphorus than a similar iron less gray in character; and when very white metal is being made a considerable reduction in the phosphorus percentage may ensue; but for such an iron there is no demand.

THE IRON MOLDERS' JOURNAL

Has a contributed chapter on "Plain Hints in Malleable Jobbing," taking up the special difficulties usually presenting themselves for consideration in this class of work and offering remedies for counteracting the same.

D. Black, Sr., writes entertainingly of "Two Tricks of the Trade," and shows to what extent age confers on practical men

the ability to see themselves as others see them. It is a well-written exposition of things we meet with in every-day life and of especial value to those actually engaged in molding.

THE TRADESMAN

For September 1 has considerable original matter contributed by E. H. Putnam, who dwells with especial force upon the evil effects of running a shop with makeshifts.

September 15.—The same author treats of "The Future of Iron Founding in the Chattanooga District," and shows by what superb natural facilities this southern district will command to itself a great increase in the manufacture of iron products, and one can only wonder why the treasures, in the form of iron and coal, have so long been shipped away and returned again as manufactured goods, when every facility obtainable elsewhere is also to be found here for converting the raw material into the finished product.

ACTIVE MEMBERS.

June 25, 1896—Abendroth Bros..................Port Chester, N. Y.
July 9, 1896—Aermotor Co.............12th, Rockwell & Fillmore, Chicago, Ill.
July 17, 1896—American Radiator Co..................Detroit, Mich.
June 29, 1896—Amsden, Alonzo D...............Phoenix Foundry, Providence, R. I.
Sept. 14, 1896—Anniston Pipe & Foundry Co...........Anniston, Ala.
July 22, 1896—Babington, B. B........B. B. Babington, Son & Co., Shelby, N. C.
Nov. 18, 1896—Baltimore Car Wheel Co., The...........Baltimore, Md.
July 10, 1896—Barbour-Stockwell Co...............205 Broadway, Cambridgeport, Mass.
July 17, 1896—Beckett, James A....W. A. Wood Mowing & Reaping Co., Hoosick Falls, N. Y.
Nov. 18, 1896—Belcher & Taylor Agricultural Tool Co., The...... Chicopee Falls, Mass
Nov. 4, 1896—Bell Co., The C. S........................Hillsboro, O.
June 28, 1896—Blackburn, A. H.............Fuel Economizer Co., Matteawan, N. Y.
Sept. 10, 1896—Blymyer Iron Works Co., The........Cincinnati, Ohio.
Nov. 30, 1896—Brigden, Chas. H.......................Yonkers, N. Y.
Oct. 19, 1896—Buckingham, Geo. B......Arcade Malleable Iron Co., Worcester, Mass.
Nov. 18, 1896—Burlington Route Foundry.................Aurora, Ill.
July 13, 1896—Buffalo Forge Co.......................Buffalo, N. Y.
Nov. 16, 1896—Christie M. E., E. W....................Carteret, N. J.
Nov. 16, 1896—Colton & Co., G. D......................Galesburg, Ill.
June 24, 1896—Corbin, P. & F...................New Britain, Conn.
June 11, 1896—Campbell, Twining......................Paterson, N. J.
Aug. 28, 1896—Carnegie Steel Co., The.................Pittsburg, Pa.
July 20, 1896—Carpenter, A. & Sons.............272 W. Exchange, Providence, R. I.
June 27, 1896—Cavanaugh, Francis......Quakertown Stove Works, Quakertown, Pa.
June 20, 1896—Cheney & Son, S.......................Manlius, N. Y.
June 23, 1896—Choate, Chas. N., Bridgeport, Deox., Bronze & Metal Co., Bridgeport, Conn.
June 16, 1896—Colvin, Theo. H......Theo. H. Colvin Foundry Co., Providence, R. I.
June 21, 1896—Colorado Fuel & Iron Co..................Pueblo, Col.
July 1, 1896—Connersville Blower Co..................Connersville, Ind.
July 11, 1896—Condor Iron Foundry Co...........East Boston, Mass.
June 26, 1896—Co-operative Foundry Co...............15 Hill St., Rochester, N. Y.

Nov. 15, 1896—Davenport & Treacy Co.................Stamford, Conn.
Nov. 15, 1896—Davis & Farnum Mfg. Co................Waltham, Mass.
Nov. 19, 1896—Davis Iron Works Co., The F. M............Denver, Col.
June 29, 1896—Davis Foundry Co........................Lawrence, Mass.
July 18, 1896—Day, F. M..................Hopedale Machine Co., Hopedale, Mass.
Aug. 24, 1896—Dickson Mfg. Co..........................Scranton, Pa.
June 22, 1896—Dighton Furnace Co......................Taunton, Mass.
June 29, 1896—Donaldson, J. F.........Ingersoll-Sergeant Drill Co., 640 Wolf St., Easton, Pa.
June 19, 1896—Drummond Mfg. Co.....................Louisville, Ky.
Sept. 7, 1896—Dry Dock Engine Works.................Detroit, Mich.
Nov. 3, 1896—DuBois Iron Works..........................DuBois, Pa.
Nov. 18, 1896—Eaton, Cole & Burnham Co., The......Bridgeport, Conn.
Aug. 26, 1896—Erie Malleable Iron Co., Ltd..................Erie, Pa.
July 1, 1896—Evans, Henry Clay......Mgr. Chattanooga Car & Fdy. Co., Chattanooga, Tenn.
June 28, 1896—Fisher, John E., Foreman Foundry, National Transit Co., Oil City, Pa.
July 1, 1896—Flagg, Stanley G. & Co....19th and Pennsylvania ave., Philadelphia, Pa.
Aug. 29, 1896—Flather, Frederick A........Lowell Machine Shop, Lowell, Mass.
June 25, 1896—Frank-Kneeland Machine Co...............54th St., Pittsburg, Pa.
Sept. 8, 1896—Frontier Iron Works......................Detroit, Mich.
June 18, 1896—Gibby, F. W......Prest. Mechanics' Iron Fdy. Co., 38 Kemble St., Roxbury, Mass.
July 11, 1896—Gillette-Herzog Mfg. Co..............Minneapolis, Minn.
July 1, 1896—Girard Iron Works...................22d & Master, Philadelphia, Pa.
Nov. 27, 1896—Gisriel, Wm...............Maryland Brass & Metal Works Baltimore, Md.
Nov. 27, 1896—Griffing Iron Co., A. A.................Jersey City, N. J.
Nov. 18, 1896—Griffin Wheel Co..........................Detroit, Mich.
July 5, 1896—Groves, S.....................Taylor, Wilson & Co., Allegheny, Pa.
July 19, 1896—Hanson, Wm........5404 Lancaster ave., Philadelphia, Pennsylvania Iron Works Co., Philadelphia, Pa.
Nov. 15, 1896—Hinckley & Egery Iron Co..................Bangor, Me.
Aug. 26, 1896—Hodge & Co., Samuel F..................Detroit, Mich.
Nov. 30, 1896—Holley, S. H...Gen. Mgr. Lake Shore Iron Works, Marquette, Mich.
July 2, 1896—Hubley Mnfg. Co..........................Lancaster, Pa.
July 2, 1896—Ingersoll-Sergeant Drill Co.........Havemeyer Bldg., New York, N. Y.

July 30, 1896—James, Geo..............Mangr. Variety Iron Works, Seattle, Wash.
June 29, 1896—Jarecki Mfg. Co., Ltd., Foundry Dept............Erie, Pa.
July 23, 1896—Jobb, Chas. L..............Londonderry Iron Co., Londonderry, N. S.
Sept. 2, 1896—Jones, E. H.......................143 S. Franklin St., Wilkes-Barre, Pa.
June 18, 1896—Keep, Wm. J............Supt. Michigan Stove Co., 753 Jefferson Ave., Detroit, Mich.
June 22, 1896—Kimball, W. G................S. G. Kimball's Sons, 127 Washington St., Newburgh, N. Y.
June 29, 1896—Kitchell, H. G................Delta Machine Co., Greenwood, Miss.
June 29, 1896—Knoeppel, John C..Foreman Foundry Buffalo Forge Co., 540 Swan St., Buffalo, N. Y.
Nov. 15, 1896—Knowles Steam Pump Works..............Warren, Mass.
June 29, 1896—Koken, Wm. T.................Koken Iron Works, St. Louis, Mo.
July 9, 1896—Koons, Jos.........With L. V. R. R. Co., Weatherly, Pa.
June 16, 1896—Lane Mfg. Co..........................Montpelier, Vt.
June 27, 1896—Leechburg Fdy. & Mach. Co............Lewis Blk., Pittsburg, Pa.
July 4, 1896—LeBaron Foundry Co..............Middleborough, Mass.
Sept. 19, 1896—Leland & Faulconer Mfg. Co............Detroit, Mich.
Sept. 2, 1896—Letchworth, O. P.....Pres. Pratt & Letchworth Co., Buffalo, N. Y.
June 29, 1896—Lincoln, Geo. H. & Co.............South Boston, Mass.
July 11, 1896—Little, Owen J......Propr. Deckertown Foundry and Machine Shops, Deckertown, N. J.
June 19, 1896—Lutterman, T. F. A...Foreman National Supply Co., 1422 Baxter St., Auburndale, O.
June 18, 1896—Magee Furnace Co.....................Boston, Mass.
July 28, 1896—Maher & Flockhart......................Newark, N. J.
July 3, 1896—Malleable Iron Fittings Co.............Brandford, Conn.
July 13, 1896—Mathes, Ph..........Brittan, Graham & Mathes Co., 411 Wood St., Pittsburg, Pa.
Aug. 27, 1896—Matlack, David J................2247 Richmond St., Philadelphia, Pa.
Sept. 21, 1896—McLagon Foundry Co..............New Haven, Conn.
Sept. 26, 1896—Michigan Malleable Iron Co..............Detroit, Mich.
Aug. 26, 1896—The Michigan Stove Co.................Detroit, Mich.
Oct. 21, 1896—Milwaukee Harvester Co.............Milwaukee, Wis.
Aug. 31, 1896—Moore, D. G.....Pres. The S. L. Moore & Sons Co., Elizabeth, N. J.
June 29, 1896—Morris & Barlow...........28 Orange St., Newark, N. J.
June 29, 1896—Morris, Wheeler & Co..........16th and Market Sts., Philadelphia, Pa.

July 8, 1896—Mosher Mfg. Co............................Dallas, Tex.
July 10, 1896—Newburgh Ice Mch. & Eng. Co., Edgar Penney, Pres., Newburgh, N. Y.
June 23, 1896—Nicholas, W. H.......Foreman of Foundry P. R. R., Renova, Pa.
July 20, 1896—Northwestern Malleable Iron Co........Milwaukee, Wis.
Sept. 24, 1896—North & Judd Mfg. Co..............New Britain, Conn.
Aug. 12, 1896—Olympic Iron Works..................Tacoma, Wash.
Aug. 26, 1896—Osborne, D. M..........................Auburn, N. Y.
June 25, 1896—Osgood & Hart....3 Sherman St., Charlestown Dist., Boston, Mass.
July 10, 1896—Patterson, Wm. E......Brown & Patterson, 33 Marcy Ave., Brooklyn, N. Y.
June 19, 1896—Penton, John A......Editor "Foundry," Detroit, Mich.
Sept. 22, 1896—Pittsburg Malleable Iron Co...............Pittsburg, Pa.
Nov. 27, 1896—Potter Printing Press Co...............Plainfield, N. J.
July 15, 1896—Pratt & Whitney Co.....................Hartford, Conn.
July 10, 1896—Ridgway, Craig & Son.................Coatesville, Pa.
July 18, 1896—Riehl, Wm........Nat. Fdy. & Mach. Co., Louisville, Ky.
June 19, 1896—Robinson-Rea Mfg. Co.....329 Water St., Pittsburg, Pa.
June 19, 1896—Rohland, John....Supt. Coxe Iron Mfg. Co., Drifton, Pa.
July 8, 1896—Roots, P. H. & F. M. Co...............Connersville, Ind.
June 26, 1896—Russell & Erwin Mfg. Co...........New Britain, Conn.
June 17, 1896—Russel, John R......Sec'y Russel Wheel & Fdy. Co., Detroit, Mich.
Sept. 7, 1896—Sawyer, James C..........Somersworth Machine Co., Dover, N. H.
June 17, 1896—Schumann, Francis..Pres't Tacony Iron & Metal Co., Tacony, Pa.
June 27, 1896—Seaman-Sleeth Co...............41st St. and Willow, Pittsburg, Pa.
Aug. 31, 1896—Sellers & Co., Wm..................Philadelphia, Pa.
Sept. 5, 1896—Sessions Foundry Co......................Bristol, Conn.
June 25, 1896—Sheppard, Isaac A. & Co...............Philadelphia, Pa.
June 29, 1896—Shickle, Harrison & Howard Iron Co......St. Louis, Mo.
June 24, 1896—Sleeth, S. D...........Westinghouse Air Brake Co., Pittsburg, Pa.
Nov. 15, 1896—Smith Co., The H. B....................Westfield, Mass.
July 1, 1896—Smith, Pemberton............N. Y. Car Wheel Works, Buffalo, N. Y.
Nov. 19, 1896—Snead-Van Alstine-Meldrum Co., The......Louisville, Ky.
June 17, 1896—Sorge, A. Jr....................1533 Marquette Bldg., Chicago, Ill.
July 15, 1896—Springer, Jos. H....Supt. Mich. Brass & Iron Works, Detroit, Mich.
July 13, 1896—St. Paul Foundry Co.....................St. Paul, Minn.
Aug. 29, 1896—Stevens, W. W..........9th and Montgomery Ave., Philadelphia, Pa.

Aug. 29, 1896—Sweeney, John M...Pres't Consolidated Iron & Steel Co., Harvey, Ill.
June 1, 1896—Syracuse Chilled Plow Co................Syracuse, N. Y.
July 13, 1896—Taft, C. A......................Whitin Machine Co., Whitinsville, Mass.
Nov. 18, 1896—Taylor Iron & Steel Co.............High Bridge, N. J.
June 17, 1896—Taylor, Robt.........Chairman Taylor-Wilson & Co., Allegheny, Pa.
June 17, 1896—Taylor-Wilson & Co., Ltd..............Allegheny, Pa.
July 8, 1896—Thompson, Josiah..............J. Thompson & Co., Philadelphia, Pa.
Aug. 26, 1896—Torrance Iron Co.........................Troy, N. Y.
June 27, 1896—Treat, C. A., Mfg. Co.................Hannibal, Mo.
July 18, 1896—Trenton Malleable Iron Co.............Trenton, N. J.
Nov. 19, 1896—Union Malleable Iron Co....................Moline, Ill.
July 8, 1896—Walker & Pratt Mfg. Co................Watertown, Mass.
July 20, 1896—Wallis, Philip..........M. M.; L. V. R. R., Hazleton, Pa.
June 19, 1896—Warden, King & Son..................Montreal, P. Q.
June 17, 1896—Waterbury-Farrell Foundry & Machine Co., Waterbury, Conn.
July 13, 1896—Watson, James......Otis Bros. & Co., 61 Hudson St., Yonkers, N. Y.
June 27, 1896—West, Thos. D....Vice-Pres. & Mngr. Thos. D. West Foundry Co., Sharpsville, Pa.
Nov. 17, 1896—Western Foundry Co..........38th St. and Albany Av., Chicago, Ill.
Nov. 15, 1896—White & Sons, Patrick...............Perth Amboy, N. J.
Sept. 2, 1896—Whitney, Asa W................1601 Callowhill St., Philadelphia, Pa.
Nov. 23, 1896—Whiteley, Burt H....................Whiteley Mall. Castings Co., Muncie, Ind.
Nov. 15, 1896—Whitney Iron Works Co., The........New Orleans, La.
Nov. 15, 1896—Whiting Foundry & Equipment Co..........Harvey, Ill.
July 3, 1896—Wilbraham-Baker Blower Co...........Philadelphia, Pa.
July 15, 1896—Wood, Walter....R. D. Wood & Co., 400 Chestnut St., Philadelphia, Pa.
Sept. 2, 1896—Worthington, Henry R.............Van Brunt St., Brooklyn, N. Y.
June 18, 1896—Yagle, Wm. & Co., Ltd........32d St. & A. V. R. R., Pittsburg, Pa.

ASSOCIATE.

Nov. 15, 1896—Adams & Co., Hugh W............15 Beekman St., New York, N. Y.
July 31, 1896—Andrew Bros.' Co................Mnfrs. of Pig Iron, Youngstown, O.

July 12, 1896—Burget, R. A....Treas. and Gen. Mgr. Richmond Iron Works, Richmond Furnace, Mass.

Oct. 1, 1896—Cleveland Facing Mill Co..................Cleveland, O.

June 29, 1896—Dixon Crucible Co., Jos. Mfrs. Crucibles and Foundry Facings, Jersey City, N. Y.

July 8, 1896—Findley, A. I............Editor "Iron Trade Review," Cleveland, O.

Aug. 7, 1896—Garden City Sand Co..Molding Sand and Fire Brick, Chicago, Ill.

June 17, 1896—Goodrich, F. A. & Co.............Pig Iron Dealers, 926 Chamber of Commerce, Detroit, Mich.

July 1896—Gobeille Pattern Co...................Mfrs. of Patterns, Cleveland, O.

July 11, 1896—Hanson & Van Winkle Co..Mfrs. of Foundry Nickel Plating Outfits, Newark, N. J.

July 17, 1896—Howe, Arthur W—Pig Iron Dealer, 420 Bourse Bldg., Philadelphia, Pa.

July 10, 1896—Hussman Crucible Co..............Mfrs. of Crucibles, 810 Commercial Bldg., St. Louis, Mo.

July 6, 1896—Kirk, Dr. E...........................Philadelphia, Pa.

July 14, 1896—Kittanning Iron & Steel Mfg. Co........Kittanning, Pa.

June 16, 1896—McCormick, J. S., Co.............Foundry Supplies, Pittsburg, Pa.

July 20, 1896—McCullough & Dalzell Co..........Mfrs. of Crucibles, Pittsburg, Pa.

July 10, 1896—Miller, Alfred J......Vice-Pres. Whitehead Bros.' Co., 42 S. Water St., Providence, R. I.

June 29, 1896—Millett Core Oven Co.....Mfrs. of Millett Core Oven Brightwood, Mass.

July 3, 1896—Obermayer, S., Co.................Foundry Supplies, Cincinnati, O.

July 6, 1896—Paxson, J. W. & Co...............Foundry Supplies, Philadelphia, Pa.

July 20, 1896—Pettinos, Geo. F.....Pettinos Bros., Foundry Facings, Bethlehem, Pa.

July 7, 1896—Pickands, Brown & Co., Mfrs. & Dealers of Pig Iron, Rookery Bldg., Chicago, Ill.

June 29, 1896—Pickands, Mather & Co..Mfrs. & Dealers of Pig Iron, Cleveland, O.

July 26, 1896—Rock Run Iron & Mining Co.............Rock Run, Ala.

July 19, 1896—Rogers, Brown & Co..............Pig Iron Dealers, New York, N. Y.

July 22, 1896—Rogers, Brown & Warner..........Pig Iron Dealers, Bullitt Bldg., Philadelphia, Pa.

July 17, 1896—Tabor Mfg. Co., The........Mfrs. Molding Machines,
Elizabeth, N. J.
Aug. 17, 1896—Taylor & Son, Robt. J............Mfrs. of Crucibles,
Philadelphia, Pa.
July 14, 1896—Timmis & Clissold...................Bound Brook, N. J.
Oct. 31, 1896—Tradesman Publishing Co............Chattanooga, Tenn.
June 20, 1896—Translucent Fabric Co..Mrfs. of Translucent Fabric,
Quincy, Mass.
Sept. 19, 1896—Washington Coal & Coke Co..............Pittsburg, Pa.
June 30, 1896—Wells Light Mfg. Co., The......Mfrs. of Wells Light,
44-46 Washington St., New York, N. Y.

LIST OF MEMBERS ARRANGED ALPHABETICALLY AS TO RESIDENCE.

ALABAMA.

Anniston—Anniston Pipe & Foundry Co.
Rock Run—Rock Run Iron & Mining Co.

COLORADO.

Denver—The F. M. Davis Iron Works Co.
Pueblo—Colorado Fuel & Iron Co.

CONNECTICUT.

Brandford—Malleable Iron Fittings Co.
Bridgeport—Chas. N. Choate Deox. Bronze & Metal Co.... The Eaton, Cole & Burnham Co.
Bristol—The Sessions Foundry Co.
Hartford—Pratt & Whitney Co.
New Britain—P. & F. Corbin.... North & Judd Mfg. Co.... Russell & Erwin Mfg. Co.
New Haven—McLagon Foundry Co.
Stamford—Davenport & Treacy Co.
Waterbury—Waterbury-Farrell Foundry & Machine Co.

ILLINOIS.

Aurora—Burlington Route Foundry Co.
Chicago—Aermotor Co., 12th, Rockwell & Fillmore.... Pickands, Brown & Co.... Garden City Sand Co.... A. Sorge, Jr., 1533 Marquette Bldg.
Galesburg—G. D. Colton & Co.
Harvey—John M. Sweeney, Pres't Consolidated Iron & Steel Co.... Whiting Foundry & Equipment Co.
Moline—Union Malleable Iron Co.
Muncie—Burt H. Whiteley, Whiteley Malleable Castings Co.

INDIANA.

Connersville—The Connersville Blower Co.... P. H. & F. M. Roots Co.

KENTUCKY.

Louisville—The Drummond Mfg. Co.... Wm. Reihl, National Foundry & Machine Co.... The Snead-Van Alstine-Meldrum Co.

LOUISIANA.

New Orleans—The Whitney Iron Works Co.

MAINE.

Bangor—Hinckley & Egery Iron Co.

MARYLAND.

Baltimore—Baltimore Car Wheel Co....Wm. Gisriel, Maryland Brass & Metal Works.

MASSACHUSETTS.

Boston—Magee Furnace Co....Osgood & Hart, 3 Sherman St., Charlestown Dist.
Brightwood—Millett Core Oven Co.
Cambridgeport—Barbour-Stockwell Co.
Chicopee Falls—The Belcher & Taylor Agricultural Tool Co.
East Boston—Condor Iron Foundry Co.
Hopedale—F. M. Day, Hopedale Machine Co.
Lawrence—Davis Foundry Co.
Lowell—Frederick A. Flather, Lowell Machine Shop.
Middleborough—LeBaron Foundry Co.
Quincy—Translucent Fabric Co.
Richmond Furnace—R. A. Burget, Treas. and Gen. Mgr. Richmond Iron Works.
Roxbury—F. W. Gibby, 38 Kemble St.
South Boston—Geo. H. Lincoln & Co.
Tauton—Dighton Furnace Co.
Watertown—Walker & Pratt Mfg. Co.
Waltham—Davis & Farnum Mfg. Co.
Warren—Knowles Steam Pump Works.
Westfield—The H. B. Smith Co.
Whitinsville—C. A. Taft, Whitin Machine Co.

MICHIGAN.

Detroit—American Radiator Co....Dry Dock Engine Works....Frontier Iron Works....F. A. Goodrich & Co....Griffin Wheel Co....Samuel F. Hodge & Co....Wm. J. Keep, Supt. Michigan Stove Co....Leland & Faulconer Mfg. Co....The Michigan Malleable Iron Co.... The Michigan Stove Co....John A. Penton, Editor "Foundry".... John R. Russel, Sec'y Russel Wheel & Foundry Co....Joseph H. Springer, Supt. Michigan Brass & Iron Works.
Marquette—S. H. Holley, Gen. Mgr. Lake Shore Iron Works.

MINNESOTA.

Minneapolis—Gillette-Herzog Mfg. Co.
St. Paul—St. Paul Foundry Co.

MISSISSIPPI.

Greenwood—H. G. Kitchell, Delta Machine Co.

MISSOURI.

Hannibal—C. A. Treat Mfg. Co.
St. Louis—Hussman Crucible Co....Wm. K. Koken, Koken Iron Works.

NEW HAMPSHIRE.

Auburn—D. M. Osborne & Co.
Dover—James C. Sawyer, Somersworth Machine Co.
Scranton—Dickson Mfg. Co.

NEW JERSEY.

Bound Brook—Timmis & Clissold.
Carteret—E. W. Christie, M. E.
Deckertown—Owen J. Little, Prop. Deckertown Foundry & Machine Shops.
Elizabeth—The Tabor Mfg. Co....D. G. Moore, Pres. The S. L. Moore & Sons' Co.
High Bridge—Taylor Iron & Steel Co.
Jersey City—Jos. Dixon Crucible Co....A. A. Griffing Iron Co.
Newark—Honson & Van Winkle Co....Maher & Flockhart....Morris & Barlow, 28 Orange St.
Paterson—Twining Campbell.
Perth Amboy—Patrick White & Sons.
Plainfield—Potter Printing Press Co.
Trenton—Trenton Malleable Iron Co.

NEW YORK.

Brooklyn—Wm. E. Patterson, 33 Marcy Ave....Henry R. Worthington, Van Brunt St.
Buffalo—Buffalo Forge Co....John C. Knoeppel, foreman Buffalo Forge Co., 540 Swan St....Pemberton Smith, New York Car Wheel Works....O. P. Letchworth, Pres. Pratt & Letchworth Co.
Hoosick Falls—Beckett A. James, W. A. Wood Mowing & Reaping Co.
Manlius—S. Cheney & Son.
Matteawan—A. H. Blackburn, Fuel Economizer Co.
Newburgh—W. G. Kimball, 127 Washington St....Newburgh Ice Machine & Engine Co.
New York—H. W. Adams & Co., 15 Beekman St....Ingersoll-Sergeant Drill Co., Havemeyer Bldg....Roger Brown & Co....The Wells Light Mfg. Co., 44-46 Washington St.
Port Chester—Abendroth Bros.
Rochester—Co-operative Foundry Co., 15 Hill St.
Syracuse—Syracuse Chilled Plow Co.
Troy—Torance Iron Co.
Yonkers—James Watson, Otis Bros. & Co., 61 Hudson St....Chas. H. Brigden, Dock cor. River St.

NORTH CAROLINA.

Shelby—B. B. Babington, B. B. Babington, Son & Co.

OHIO.

Auburndale—T. F. A. Lutterman, Foreman National Supply Co., 1422 Baxter St.
Cincinnati—The Blymyer Iron Works Co....S. Obermayer Co.
Cleveland—The Cleveland Facing Mill Co....A. I. Findlay, Editor "Iron Trade Review"....Gobeille Pattern Co....Pickands, Mather & Co.
Hillsboro—The C. S. Bell Co.
Youngstown—Andrews Bros.' Co., Mfrs. of Pig Iron.

PENNSYLVANIA.

Allegheny—S. Groves, Taylor, Wilson & Co....Robert Taylor, Chairman Taylor, Wilson & Co....Taylor, Wilson & Co., Ltd.
Bethlehem—Geo. F. Pettinos.
Coatesville—Craig-Ridgway & Son.
Drifton—John Rohland, Supt. Coxe Iron Mfg. Co.
DuBois—DuBois Iron Works.
Easton—J. F. Donaldson, 640 Wolf St.
Erie—Jarecki Mfg. Co., Ltd....Erie Malleable Iron Co., Ltd., Box 485.
Hazelton—Philip Wallis, M. M.; L. V. R. R.
Kittanning—Kittanning Iron & Steel Mfg. Co.
Lancaster—Hubley Mfg. Co.
Oil City—John E. Fisher, Foreman Foundry, National Transit Co.
Pittsburg—The Carnegie Steel Co., Ltd....Frank-Kneeland Machine Co....Leechburg Foundry & Machine Co....Ph. Mathes, 411 Wood St., Brittain, Graham & Mathes Co....J. S. McCormick Co....McCullough & Dalzell Co....Pittsburg Malleable Iron Co....Robinson-Rae-Mfg. Co., 329 Water St....Seaman-Sleeth Co., 41st St. and Willow....S. D. Sleeth, Westinghouse Air Brake Co....Washington Coal & Coke Co....Wm. Yagle & Co., Ltd., 23d St. and A. V. R. R.
Philadelphia—Stanley G. Flagg & Co., 19th and Pennsylvania Ave.... Girard Iron Works, 22d and Master....Wm. Hanson, 5404 Lancaster Ave....Arthur W. Howe....Dr. Edward Kirk, 535 N. 10th St.... Morris Wheeler & Co., 16th and Market Sts....J. W. Paxson & Co....Rogers, Brown & Warner, Bullitt Bldg....Isaac A. Sheppard & Co....Robert J. Taylor & Son....Josiah Thompson, J. Thompson & Co....Wilbraham Baker Blower Co....Walter Wood, R. D. Wood & Co., 400 Chestnut St....David J. Matlack, 2247 Richmond St.... Wm. Sellers & Co., Inc., 1600 Hamilton St....W. W. Stevens, 9th and Montgomery Ave....Asa W. Whitney, 1601 Callowhill St.
Quakertown—Francis Cavanaugh, Quakertown Stove Works.
Renova—W. H. Nicholas, P. R. R., Foreman of Foundry.
Sharpsville—Thos. D. West, Vice-Pres. and Mgr. Thos. D. West Foundry Company.
Tacony—Francis Schumann, Tacony Iron & Metal Co.
Weatherly—Jos. Koons, with L. V. R. R. Co.
Wilkes-Barre—E. H. Jones, 143 S. Franklin St.

RHODE ISLAND.

Providence—Alonzo D. Amsden, Phoenix Foundry....A. Carpenter & Sons, 272 W. Exchange....Theo. H. Colvin, Theo. H. Colvin Foundry Co....Alfred J. Miller, Vice-Pres. Whitehead Bros.' Co.

TENNESSEE.

Chattanooga—Henry Clay Evans, Mgr. Chattanooga Car & Foundry Co....Tradesman Publishing Co.

TEXAS.

Dallas—Mosher Mfg. Co.

VERMONT.

Montpelier—Lane Mfg. Co.

WASHINGTON.

Seattle—Geo. James, Mgr. Variety Iron Works.
Tacoma—Olympic Iron Works.

WISCONSIN.

Milwaukee—Northwestern Malleable Iron Co.

CANADA.

Londonderry—Chas. L. Jobb, Londonderry Iron Co.
Montreal, P. Q.—Warden King & Son.
Nov. 30, 1896—Brigden, Chas. H........................Yonkers, N. Y.
Nov. 30, 1896—Holley, S. H.....Gen. Mgr. Lake Shore Iron Works, Marquette, Mich.

LIST OF NEW MEMBERS SINCE PUBLICATION OF LAST REPORT.

Nov. 18, 1896—Baltimore Car Wheel Co., The............Baltimore, Md.
Nov. 18, 1896—Belcher & Taylor Agricultural Tool Co., The......
Chicopee Falls, Mass.
Nov. 4, 1896—Bell Co., The C. S........................Hillsboro, O.
Nov. 30, 1896—Brigden, Chas. H.........................Yonkers, N. Y.
Nov. 18, 1896—Burlington Route Foundry....................Aurora, Ill.
Nov. 16, 1896—Christie M. E., E. W......................Carteret, N. J.
Nov. 16, 1896—Colton & Co., G. D......................Galesburg, Ill.
Nov. 15, 1896—Davenport & Treacy Co.................Stamford, Conn.
Nov. 15, 1896—Davis & Farnum Mfg. Co................Waltham, Mass.
Nov. 19, 1896—Davis Iron Works Co., The F. M............Denver, Col.
Nov. 3, 1896—DuBois Iron Works.........................DuBois, Pa.
Nov. 18, 1896—Eaton, Cole & Burnham Co., The......Bridgeport, Conn.
Nov. 27, 1896—Gisriel, Wm...............Maryland Brass & Metal
Works, Baltimore, Md.
Nov. 27, 1896—Griffing Iron Co., A. A.................Jersey City, N. J.
Nov. 18, 1896—Griffin Wheel Co..........................Detroit, Mich.
Nov. 15, 1896—Hinckley & Egery Iron Co..................Bangor, Me.
Nov. 30, 1896—Holley, S. H., Gen. Mgr. Shore Iron Works,
Marquette, Mich.
Nov. 15, 1896—Knowles Steam Pump Works.............Warren, Mass.
Nov. 27, 1896—Potter Printing Press Co................Plainfield, N. J.
Nov. 15, 1896—Smith Co., The H. B....................Westfield, Mass.
Nov. 19, 1896—Snead-Van Alstine-Meldrum Co., The......Louisville, Ky.
Nov. 18, 1896—Taylor Iron & Steel Co...............High Bridge, N. J.
Nov. 19, 1896—Union Malleable Iron Co.....................Moline, Ill.
Nov. 17, 1896—Western Foundry Co...........38th St. and Albany
Av., Chicago, Ill.
Nov. 23, 1896—Whiteley, Burt H..................Whiteley Mall.
Castings Co., Muncie, Ind.
Nov. 15, 1896—Whiting Foundry & Equipment Co............Harvey, Ill.
Nov. 15, 1896—Whitney Iron Works Co., The........New Orleans, La.
Nov. 15, 1896—White & Sons, Patrick................Perth Amboy, N. J.

ASSOCIATE.

Nov. 15, 1896—Adams & Co., Hugh W...........15 Beekman St.,
New York, N. Y.
Oct. 1, 1896—Cleveland Facing Mill Co., The.............Cleveland, O.
Oct. 31, 1896—Tradesman Publishing Co...........Chattanooga, Tenn.